

Lab 11 Phase-Locked Loop

In this lab we will experiment with phase-locked loops. We will use a combination of circuit that are built from discrete components, and circuitry which is built into the 4046A chip which contains various PLL circuit components.

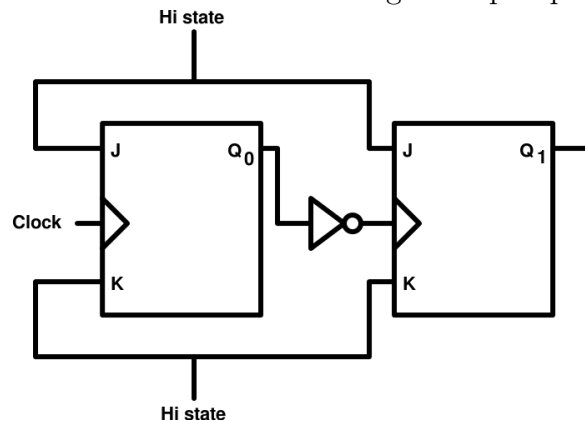
Note: Make sure you use the 4046A version, not the 4046B version.

Pre-Lab

1. Obtain the data sheet for the 4046A, the 74HC86 XOR gates, and the 74HC76 JK flip-flops.
2. Design the 4-bit counter using JK flip-flops and test it in multisim
3. Design the 555-based VCO
4. Study the section in Horowitz and Hill carefully which describes the low-pass filter. Be ready to make use of that knowledge if needed.

Frequency divider

1. Build a divide-by-4 counter using JK flip-flops in the 74HC76. Here is an illustration (from Wikipedia) of a 2-bit counter built using JK flip-flops

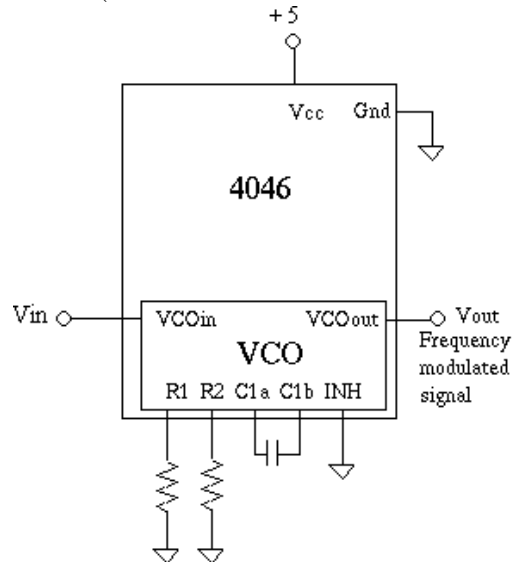


2. Verify that the frequency divider works by inputting a signal of a few kHz and seeing the output at a quarter the frequency, in phase.

Voltage-controlled oscillator

3. Pick a frequency for your VCO - for example 10 kHz.
4. Using your VCO design from lab 10, build a VCO which produces approximately that frequency for a mid-range voltage of 2.5 V

5. Verify that it works. Obtain and approximate relationship between input voltage and output frequency.
6. If you do not succeed in making the VCO function then, as a backup, use a VCO from the 4046, as shown here (refer to the 4046 data sheet for configuration information).



Phase-locked loop

7. Design the phase detector using a XOR gate and LP filter with the LP filter knee frequency approximately 1 kHz, and the zero as suggested by Horowitz and Hill.
8. Connect the VCO, the phase-detector, and the frequency divider to make a phase-locked loop.
9. Make the PLL capture, varying the input frequency until it does. Remember the input frequency will be a quarter of the output frequency you are trying to reproduce.
10. Observe that as you vary the frequency the output will remain four times the input frequency.

Frequency modulation and demodulation

11. You may remove the divider for this part.
12. Use the function generator frequency modulation to create a FM signal at the carrier frequency you picked above and much lower frequency modulation.
13. Use this signal to drive the input. Observe the modulated signal appearing on the output of the LP filter.